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IN THIS ISSUE

An Existence Theorem for OR/MS

At the outset of his **OR Forum** article, John A. White posits that four conditions are necessary and sufficient for the continued effective existence of OR/MS: that the field address real-world problems, that it employ cross-disciplinary team approaches, that it increase the participation of women, minorities, and persons with disabilities, and that it contribute to strengthening the nations' educational system. To support this view, he considers the changing character of OR/MS, considers some opportunities for it, addresses some human resources concerns facing it, and offers a view of OR/MS in the 21st century. After addressing some concerns about the higher education culture that he considers to be serious impediments to progress in the right direction, he offers some conclusions about the future of OR/MS.

OR in Chinese Agriculture

China is a developing agricultural country where the management of production depends mainly on the will and experience of its administrators. There inevitably appear one-sided views, insufficient predictions and the inability to adapt to changing circumstances. In 1982, the government of Changping County entrusted Zhon Qingzhen and his colleagues to draw up a production structure for the country in a scientific, managerial way. They established math models, investigated data and acquired the theoretical results that were put into practice; many benefits were achieved. The results caught the attention of experts in China and abroad. The achievement, called *Changing Pattern*, has spread to many countries and provinces throughout China. Good results continue to accrue. So, to spread the results on a broader scale a software system based on the agricultural production structure will be created. They report their results in "The Application of Operations Research in the Optimization of Agriculture."

Survey of Decision Analysis Applications

Decision analysis successfully addresses strategy/policy decisions that can be difficult to handle with other OR methods. This point is important because the report of the prestigious Committee on the Next Decade in Operations Research, which appeared in this journal (July-August 1988), does not mention decision analysis. Moreover, it barely mentions the type of strategy/policy questions that decision analysis can often address more effectively than other OR methods. This leaves the impression that OR methods can only be applied to repetitive, operations/tactical problems. The work surveyed in "Decision Analysis Applications in the Operations Research Literature, 1970-1989," by James Corner and Craig Kirkwood shows that this is not true. They consider decision analysis applications that have appeared in major English language OR and other closely related journals. The intent is to provide a guide to relevant source material for operations research practitioners facing situations where decision analysis might potentially be applied. Decision analysis applications may be difficult to locate because they appear in a wide variety of OR journals, often under titles that do not make it clear that decision analysis is being used.

Storing to the Best Advantage

Storage plays a key role in the operation of the supply and demand sides of electric power systems. By allowing production at one time to satisfy an end use at a subsequent time, significant economies may be achieved. In "A Rapid Method for Optimization of Linear Systems With Storage," Hugh Bannister and John Kaye report on a new technique that produces optimal schedules for the operation of facilities. While the development is based on a combination of dynamic and linear programming, exact solutions are obtained without either the descretization associated with dynamic programming or the large problem size that results when such problems are solved using LP. The limitations on the method are that the future must be known exactly and only one storage can be handled. Work is proceeding on generalizing the method. A simple-to-use, PC-based package that implements this approach is available commercially.

Determining Warehouse Size

In many distribution systems the expenses incurred for storage are significant. These expenses are usually related to the size of the facility required for storing the products. The modern techniques of automated warehouses are based on computerized systems that allow for integrated space allocation: items of several types are stored in multipurpose bins. In "Multi-Item Replenishment and Storage Problems (MIRSP): Heuristics and Bounds," S. Anily considers the managerial problem of determining the size of a warehouse storing several

items, as well as the order policy for each item. She provides solution methods that are easy to calculate with a personal computer, and are simple to implement by the user.

An Assignment With Side Constraints

A large university perceives the need for more classrooms. Academic units insist that classroom space is inadequate unless drastic changes are made in the scheduling of courses. In "Some Facets for an Assignment Problem With Side Constraints," Ronny Aboudi and George Nemhauser use an assignment problem with side constraints to model the problem of assigning courses to rooms given a fixed time schedule. The resulting model is a classical assignment problem with additional constraints that variables in certain subsets must have the same value. The crucial properties to solve the problem efficiently are not preserved when side constraints are added, and the problem is NPhard. The strong cutting plane technique has been employed to solve many NP-hard problems. This technique is problem-dependent and requires characterizing facets (or faces of high dimension) of feasible solutions. The authors describe classes of valid inequalities, some of which are facets, for this problem. They show that under the given schedule, the existing classroom space is adequate if better assignments are made.

A Customer's Sojourn Times

Knowing the average sojourn time of a customer in a queue is not enough information to evaluate its performance. For example, one might need to know how large an arrival rate a system can handle before the 99th percentile of the sojourn time distribution exceeds some threshold. Even in single server queues, the sojourn time is unknown except in the simplest cases. In "Interpolation Approximations for Sojourn Time Distributions," Phillip Fleming and Burton Simon construct an approximation for sojourn time distributions based on light and heavy traffic limits. The approximation has some desirable properties: it can be applied to any system with known traffic limits, a large class of systems, and it is in closed form in terms of the traffic limits. Most importantly, the approximation appears to be accurate for an identifiable class of systems, especially for the tail of the distribution. The *tail* is the part of interest in practical situations, and is the most difficult to approximate by simulation.

Optimal Medical Screening

Most people have periodic medical tests and examinations to detect, and hopefully, to promptly cure diseases, although there is rarely agreement in the medical community about the optimal schedule for such tests. It is difficult to determine schedules due to a variety of factors: that the onset of a disease and its treatment are random, medical tests are subject to false positives and negatives, and the costs of illness and death are difficult to put into dollar terms. Quantitative models to determine optimal screening policies may be of some help, provided they are rich enough to capture the essential features of the decision problem and yet not be so complex as to be intractable. In "Optimal Scheduling of Inspections: A Delayed Markov Model With False Positives and Negatives," Suleyman Özekici and Stanley Pliska develop a potentially useful model that they illustrate by studying policies for breast cancer screening. Their model may have application to certain repair and maintenance problems.

How to Choose The Best Partner

We wish to employ the best applicant from a pool under the assumption that applicants appear one by one in a random order, but do not necessarily accept an offer of employment. Offers may be made as many times as we like and the best applicant is interpreted as the most preferred applicant among those who will accept an offer. In "A Secretary Problem With Uncertain Employment and Best Choice of Available Candidates," Mitsushi Tamaki shows that the optimal employment policy has a threshold that depends on the previous history in a complicated manner. Another property conjectured to hold is that if it is optimal to make an offer to an applicant and the offer is declined, then it is optimal to give an offer to the next applicant if that applicant is more preferred.

Minimax Resource Allocation

Resource allocation algorithms, capable of efficiently solving large-scale problems that have some special structure, have found numerous uses in diverse application areas. In "Minimax Resource Allocation With Tree Structured Resources," Rachelle Klein and Hanan Luss were motivated by manufacturing applications in which numerous components are needed to manufacture complex, high-tech products. Often, substitutions are allowed among valuable components, such as integrated circuits. The authors develop an efficient algorithm that handles relations represented by trees, where each node can substitute for all its descendents. The algorithm finds optimal solutions to problems with thousands of resources (e.g., components) and competing activities (e.g., products) in seconds. Therefore, it can serve as a useful enhancement for modern Material Resources Planning (MRPII) systems.

Simultaneous Product-Mix Planning

When the capacity for production is limited, a manager must manage a facility to maximize profits. In "Simultaneous Product-Mix Planning, Lot Sizing and Scheduling at Bottleneck Facilities," S. H. Hum and R. K. Sarin show how a judicious selection of products to be made (product-mix) and the appropriate scheduling of these products leads to profit maximization.

Inventory Systems With Emergencies

In many large-scale inventory systems, the option exists for expediting orders through alternative modes of resupply. For example, orders that are normally shipped by sea or land, with relatively long lead times, could be shipped by air under emergency conditions at a higher cost but in a shorter lead time. In "An (S-1, s) Inventory System With Emergency Orders," Kamran Moinzadeh and Charles Schmidt study an inventory system which consists of an expensive item with probabilistic demand. They assume that there exist two options for resupply, normal and emergency, and they develop and analyze policies for placing emergency orders that use information about the age of the orders in the pipeline.

Dynamically Scheduling Manufacturing Systems

In traditional job shop scheduling problems, the sequence of machines that jobs visit are selected in advance. However, in a flexible manufacturing system, each operation of each job may be performed at any of several different machines. The resulting scheduling problem is to dynamically route each job to a machine for its next operation and to decide in which order to process jobs at each machine. In "Brownian Networks With Discretionary Routing," Lawrence Wein models this scheduling problem as a queueing network flow control problem and proposes a procedure to develop simple and effective routing and sequencing policies. The procedure is based on the observation that a heavily loaded queueing system in which customers are dynamically routed to incur the shortest expected delay will behave much like a queueing system that has sets of pooled servers and no discretionary routing options across sets of servers.

Data Verification

Data verification procedures are used in various economic areas: financial audits frequently take the form of random checks because verification of all items may be costly. Records of emissions of air or water pollutants are randomly verified by authorities. In partial fulfillment of the Non-Proliferation Treaty an organization verifies the flow of nuclear material in the nuclear plants of countries adhering to the treaty. Common to these activities is that a person or organization that has entered into binding agreement to undergo inspection is obliged to supply data to an authority, which verifies the data by its own sampling measurements. Discrepancies may occur between the reported data and the data independently observed by the inspector, which can result from deliberate falsification or measurement errors. The inspector will then have to decide, with the help of suitable statistical procedures, whether or not to accept the reported data as unfalsified, even if such data do not entirely tally with the observations. In "Optimal Data Verification Tests" by R. Avenhaus, H. P. Battenberg and B. J. Falkowski this conflict situation is modeled and analyzed in game theoretic terms. They show under which conditions a simple test procedure is optimal.